THE DATASHEET OF

BA6908F-E2

DC Brushless Motor Driver Series for Cooling Fans

Standard Single-phase Full-wave DC Brushless Fan Motor Drivers

BA6427F,BA6428F,BA6908F,BA6906F,BA6423AF,BA6424AFS

Pb Free ROHM Electronic Components
RoHS Directive Compliance

●Description

This is the summary of models of the single-phase full-wave fan motor driver with standard function.
They incorporate lock protection and automatic restart circuit.

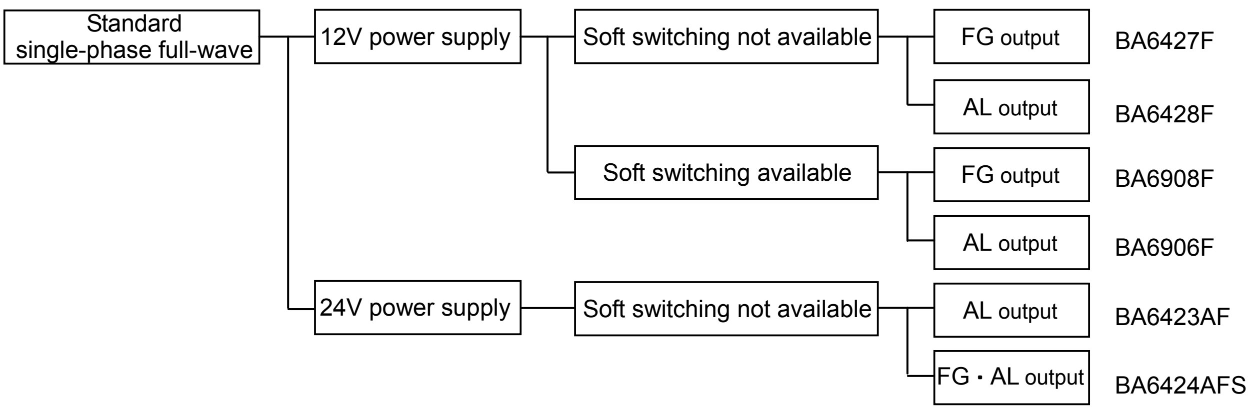
●Features

1) Lock protection and automatic restart circuit
2) Soft switched drive(BA6908F、BA6906F)
3) Rotating speed pulse signal (FG) output (BA6427F、BA6908F、BA6424AFS)
4) Lock alarm signal (AL) output (BA6428F、BA6906F、BA6423AF、BA6424AFS)

● Applications

For application of desktop PC and general consumer equipment

●Lineup



●Absolute Maximum Ratings

◎BA6427F, BA6428F

Parameter	Symbol	Limit	Unit
Supply voltage	Vcc	15	V
Power dissipation	Pd	780＊	mW
Operation temperature	Topr	-40～+85	℃
Storage temperature	Tstg	-55～+150	℃
Low side output current	Iomax	0.7＊＊	A
Output voltage	VOUT	15	V
FG signal output current	IFG	15	mA
AL signal output current	IAL	15	mA
FG signal output voltage	VFG	15	V
AL signal output voltage	VAL	15	V
Junction temperature	Tjmax	150	℃

＊ Reduce by 6.24mW/℃ over 25℃.
(On 70.0mm×70.0mm×1.6mm glass epoxy board)

＊＊ This value is not to exceed Pd.

◎BA6908F, BA6906F

Parameter	Symbol	Limit	Unit
Supply voltage	Vcc	15	V
Power dissipation	Pd	780＊	mW
Operation temperature	Topr	-40～+100	℃
Storage temperature	Tstg	-55～+150	℃
Output current	Iomax	0.7＊＊	A
Output voltage	VOUT	15	V
FG signal output current	IFG	15	mA
AL signal output current	IAL	15	mA
FG signal output voltage	VFG	15	V
AL signal output voltage	VAL	15	V
Junction temperature	Tjmax	150	℃

＊ Reduce by 6.24mW/℃ over 25℃.
(On 70.0mm×70.0mm×1.6mm glass epoxy board)

＊＊ This value is not to exceed Pd.

◎BA6423AF

Parameter	Symbol	Limit	Unit
Supply voltage	Vcc	30	V
Power dissipation	Pd	780＊	mW
Operation temperature	Topr	-40～+100	℃
Storage temperature	Tstg	-55～+150	℃
Output current	Iomax	1.0＊＊	A
Output voltage	VOUT	30	V
AL signal output voltage	VAL	30	V
Junction temperature	Tjmax	150	℃

＊ Reduce by 6.24mW/℃ over 25℃.
(On 70.0mm×70.0mm×1.6mm glass epoxy board)

＊＊ This value is not to exceed Pd.

◎BA6424AFS

Parameter	Symbol	Limit	Unit
Supply voltage	Vcc	30	V
Power dissipation	Pd	812.5＊	mW
Operation temperature	Topr	-40～+100	℃
Storage temperature	Tstg	-55～+150	℃
Output current	Iomax	1.0＊＊	A
Output voltage	VOUT	30	V
AL signal output voltage	VAL	30	V
FG signal output voltage	VFG	30	V
Junction temperature	Tjmax	150	℃

＊ Reduce by 6.24mW/℃ over 25℃.
(On 70.0mm×70.0mm×1.6mm glass epoxy board)

＊＊ This value is not to exceed Pd.

●OPERATING CONDITIONS

◎BA6427F, BA6428F

Parameter	Symbol	Limit	Unit
Operating supply voltage range	Vcc	3.0～14.0	V
Hall input voltage range	VH	0～Vcc-2.0	V

◎BA6908F, BA6906F

Parameter	Symbol	Limit	Unit
Operating supply voltage range	Vcc	3.0～14.0	V
Hall input voltage range	VH	0～Vcc-2.0	V

◎BA6423AF

Parameter	Symbol	Limit	Unit
Operating supply voltage range	Vcc	6.0～28.0	V
Hall input voltage range	VH	2.5～Vcc	V

◎BA6424AFS

Parameter	Symbol	Limit	Unit
Operating supply voltage range	Vcc	6.0～28.0	V
Hall input voltage range	VH	2.5～Vcc	V

●Truth table

◎BA6427F, BA6908F, BA6424AFS

H+	H-	OUT1	OUT2	FG
H	L	H	L	H
L	H	L	H	L

◎BA6428F, BA6906F, BA6423AF

H+	H-	OUT1	OUT2
H	L	H	L
L	H	L	H

●ELECTRICAL CHARACTERISTICS

◎BA6427F, BA6428F (Unless otherwise specified Ta=25℃,Vcc=5V)

Parameter	Symbol	Limit			Parameter	Conditions	Characteristics
		Min.	Typ.	Max.			
Circuit current	Icc	2.2	4.5	9.0	mA	At output OFF	Fig.1
Charge current of capacitor for lock detection	ILDC	1.60	2.90	4.64	μA	VLD=1.1V	Fig.2
Discharge current of capacitor for lock detection	ILDD	0.24	0.48	0.80	μA	VLD=1.1V	Fig.2
Charge-discharge current ratio of capacitor for lock detection	rCD	4.5	6.0	10.0	-	rCD=ILDC/ILDD	-
Clamp voltage of capacitor for lock detection	VLDCL	1.27	1.93	2.60	V		Fig.3
Comparison voltage of capacitor for lock detection	VLDCP	0.47	0.76	1.06	V		Fig.3
Output voltage L	VOL	-	0.2	0.3	V	Io=200mA	Fig.4
Output voltage H	VOH	3.9	4.1	-	V	Io=-200mA	Fig.5
FG output voltage L	VFGL	-	0.3	0.5	V	IFG=5mA	-
AL output voltage L	VALL	-	0.3	0.5	V	IAL=5mA	-
FG output leak current	IFGL	-	0	50	μA	VFG=15V	-
AL output leak current	IALL	-	0	50	μA	VAL=15V	-

◎BA6908F, BA6906F (Unless otherwise specified Ta=25℃,Vcc=5V)

Parameter	Symbol	Limit			Parameter	Conditions	Characteristics
		Min.	Typ.	Max.			
Circuit current	Icc	1.5	3.4	8.7	mA	At output OFF	Fig.7
Charge current of capacitor for lock detection	ILDC	1.50	2.75	4.50	μA	VLD=1.1V	Fig.8
Discharge current of capacitor for lock detection	ILDD	0.24	0.48	0.90	μA	VLD=1.1V	Fig.8
Charge-discharge current ratio of capacitor for lock detection	rCD	4.2	5.7	9.5	-	rCD=ILDC/ILDD	-
Clamp voltage of capacitor for lock detection	VLDCL	1.14	1.80	2.47	V		FIg.9
Comparison voltage of capacitor for lock detection	VLDCP	0.47	0.76	1.06	V		Fig.9
Output voltage L	VOL	-	0.2	0.3	V	Io=200mA	Fig.10
Output voltage H	VOH	3.9	4.1	-	V	Io=-200mA	Fig.11
FG output voltage L	VFGL	-	0.3	0.5	V	IFG=5mA	-
AL output voltage L	VALL	-	0.3	0.5	V	IAL=5mA	-
FG output leak current	IFGL	-	0	50	μA	VFG=15V	-
AL output leak current	IALL	-	0	50	μA	VAL=15V	-
Hall input offset voltage	Hofs	-10	-	10	mV		-
Hall input-output gain	GHO	320	500	680	-		-

◎BA6423AF (Unless otherwise specified Ta=25℃,Vcc=12V)

Parameter	Symbol	Limit			Parameter	Conditions	Characteristics
		Min.	Typ.	Max.			
Circuit current	Icc	2.7	5.4	8.1	mA	At output OFF	Fig.13
Charge current of capacitor for lock detection	ILDC	1.55	3.10	4.65	μA	VLD=1.8V	-
Discharge current of capacitor for lock detection	ILDD	0.33	0.66	0.99	μA	VLD=1.8V	-
Charge-discharge current ratio of capacitor for lock detection	rCD	3.0	4.7	6.4	-	rCD=ILDC/ILDD	-
Clamp voltage of capacitor for lock detection	VLDCL	2.00	2.48	3.00	V		-
Comparison voltage of capacitor for lock detection	VLDCP	0.70	0.99	1.30	V		-
Output voltage L	VOL	-	0.8	1.2	V	Io=200mA	Fig.14
Output voltage H	VOH	-	0.9	1.4	V	Io=-200mA	Fig.15
AL output voltage L	VALL	-	0.1	0.3	V	IAL=10mA	Fig.16
AL output leak current	IALL	-	0	10	μA	VAL=30V	-

◎BA6424AFS (Unless otherwise specified Ta=25℃,Vcc=12V)

Parameter	Symbol	Limit			Parameter	Conditions	Characteristics
		Min.	Typ.	Max.			
Circuit current	Icc	2.7	5.4	8.1	mA	At output OFF	Fig.19
Charge current of capacitor for lock detection	ILDC	1.55	3.10	4.65	μA	VLD=1.8V	-
Discharge current of capacitor for lock detection	ILDD	0.33	0.66	0.99	μA	VLD=1.8V	-
Charge-discharge current ratio of capacitor for lock detection	rCD	3.0	4.7	6.4	-	rCD=ILDC/ILDD	-
Clamp voltage of capacitor for lock detection	VLDCL	2.00	2.48	3.00	V		-
Comparison voltage of capacitor for lock detection	VLDCP	0.70	0.99	1.30	V		-
Output voltage L	VOL	-	0.8	1.2	V	Io=200mA	Fig.20
Output voltage H	VOH	-	0.9	1.4	V	Io=-200mA	Fig.21
AL output voltage L	VALL	-	0.1	0.3	V	IAL=10mA	Fig.22
AL output leak current	IALL	-	0	10	μA	VAL=30V	-
FG output voltage L	VFGL	-	0.1	0.3	V	IFG=10mA	Fig.22
FG output leak current	IFGL	-	0	10	μA	VFG=30V	-

●Reference Data

◎BA6427F/BA6428F

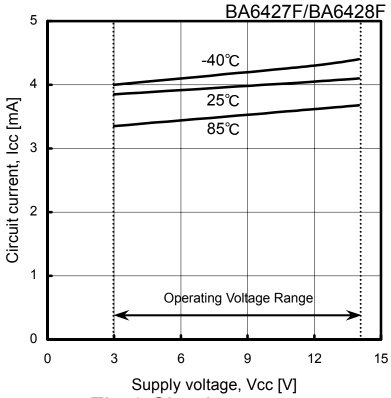


Fig.1 Circuit current

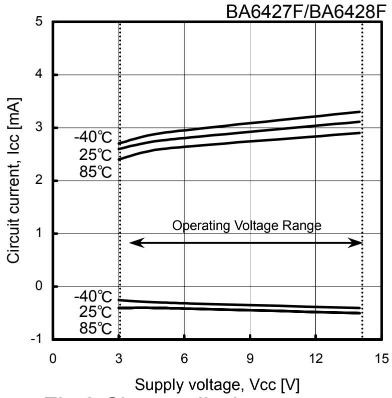


Fig.2 Charge-discharge current of capacitor for lock detection

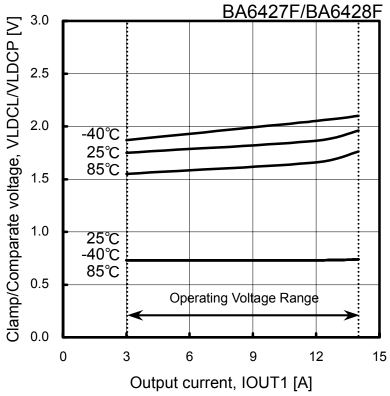


Fig.3 Clamp-comparison voltage of capacitor for lock detection

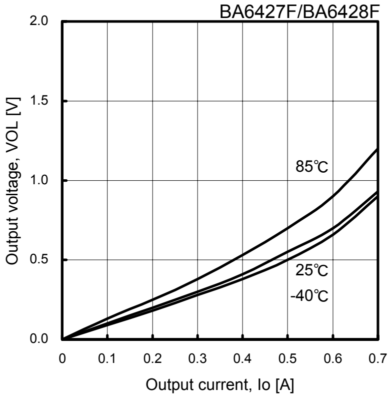


Fig.4 Output L voltage

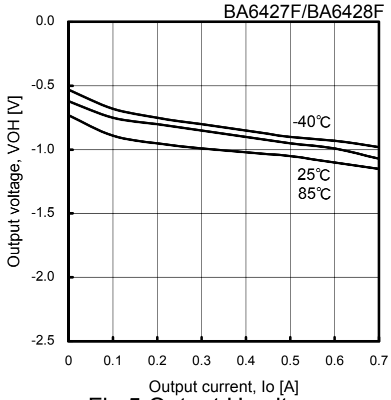


Fig.5 Output H voltage

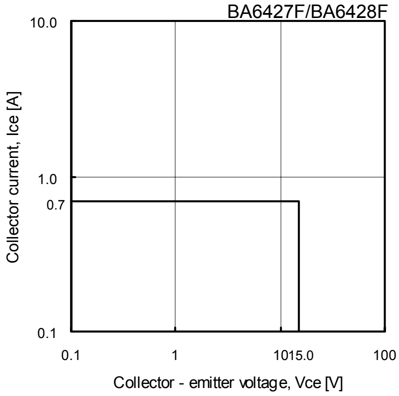


Fig.6 Output Tr ASO (Ton=100msec)

◎BA6908F/BA6906F

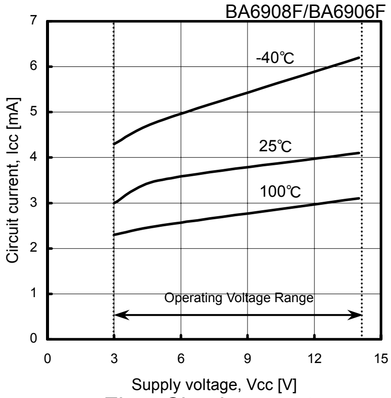


Fig.7 Circuit current

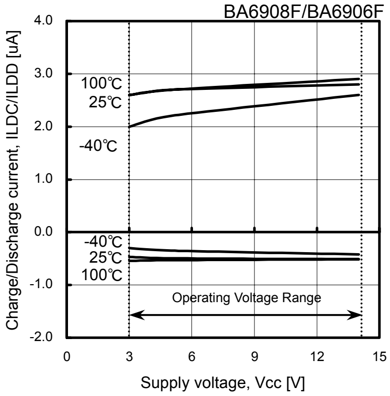


Fig.8 Charge-discharge current of capacitor for lock detection

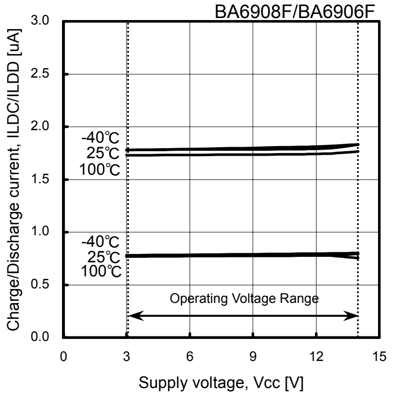


Fig.9 Clamp-comparison voltage of capacitor for lock detection

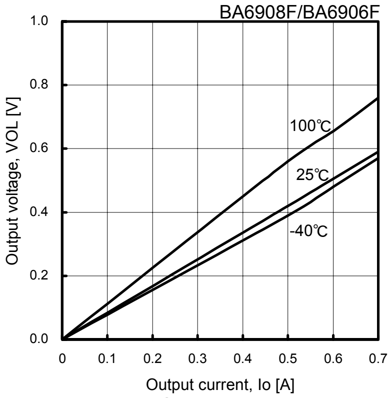


Fig.10 Output L voltage

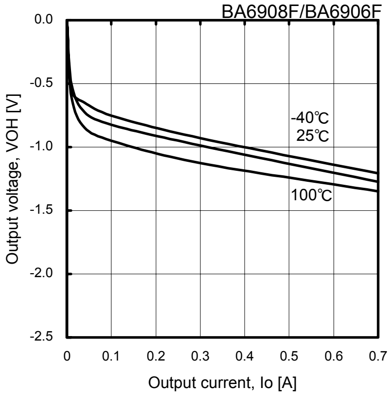


Fig.11 Output H voltage

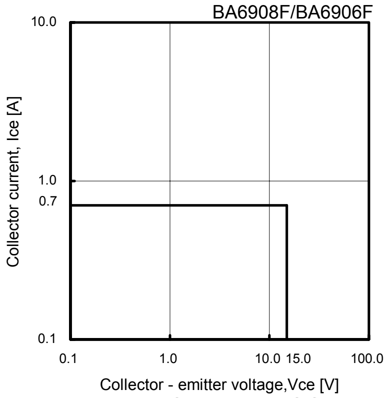


Fig.12 Output Tr ASO (Ton=100msec)

◎BA6423AF

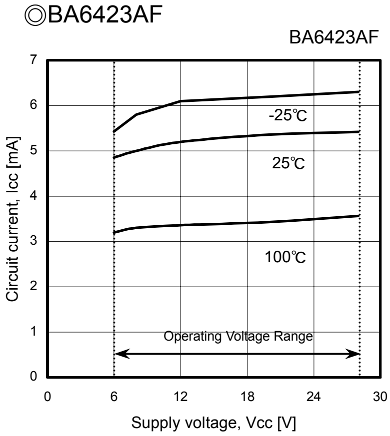


Fig.13 Circuit current

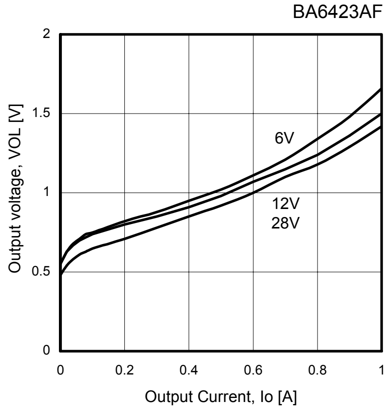


Fig.14 Output L voltage

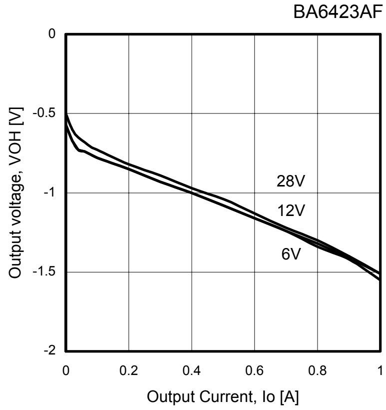


Fig.15 Output H voltage

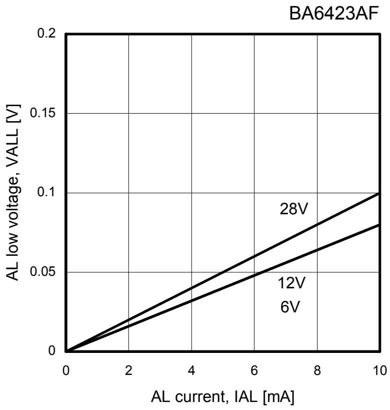


Fig.16 AL Output L voltage

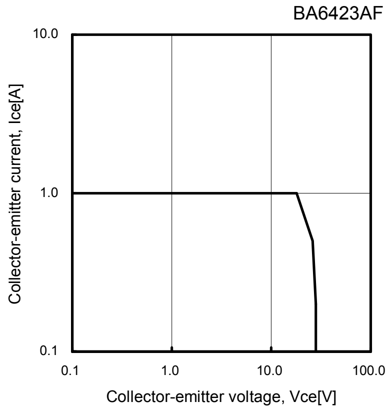


Fig.17 Output Tr ASO（upper）
(TON=100msec)

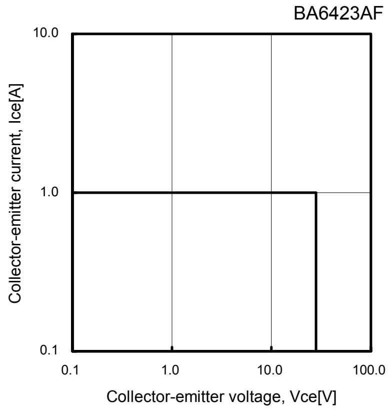


Fig.18 Output Tr ASO（lower）
(TON=100msec)

◎BA6424AFS

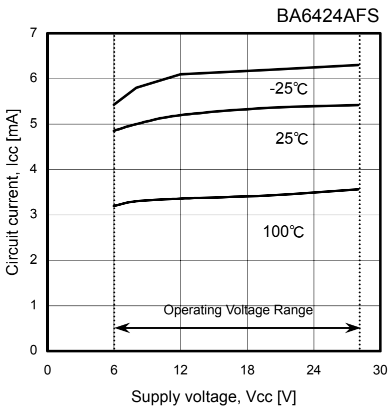


Fig.19 Circuit current

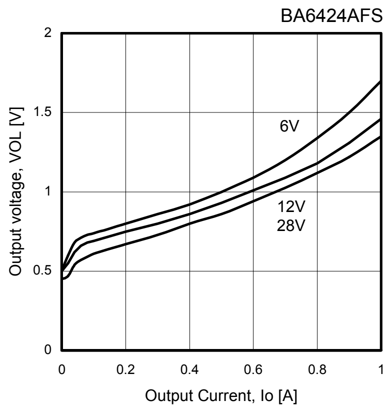


Fig.20 Output L voltage

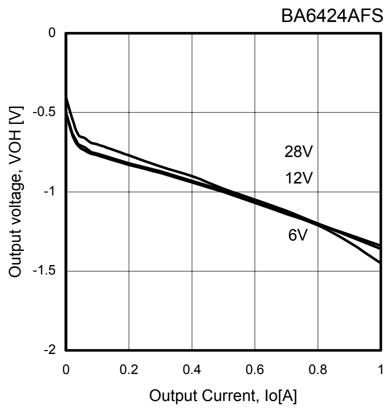


Fig.21 Output H voltage

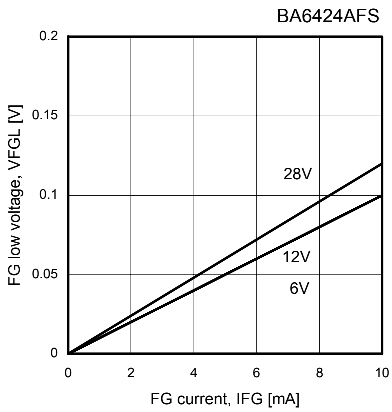


Fig.22 FG/AL Output L voltage

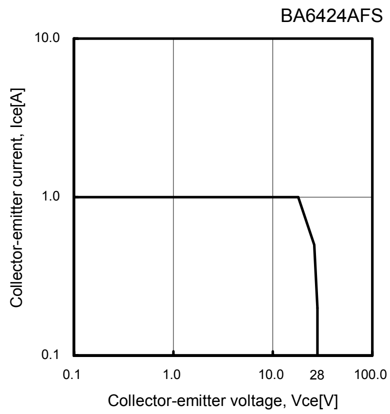


Fig.23 Output Tr ASO（upper）
(TON=100msec)

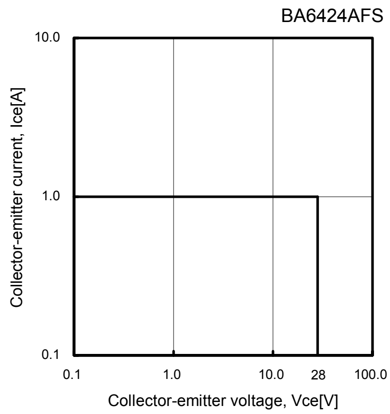
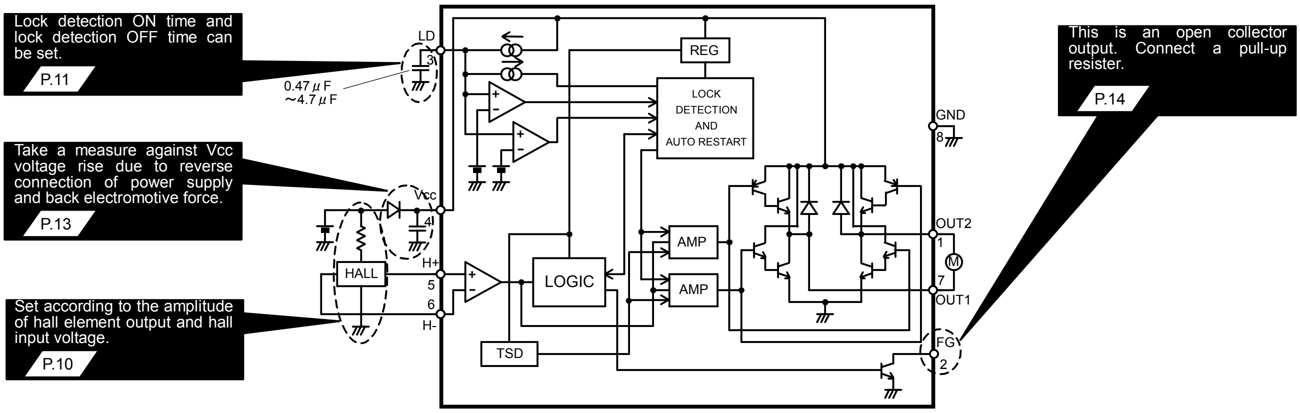


Fig.24 Output Tr ASO（lower）
(TON=100msec)

●Block diagram, application circuit, and pin assignment(Constant etc are for reference)

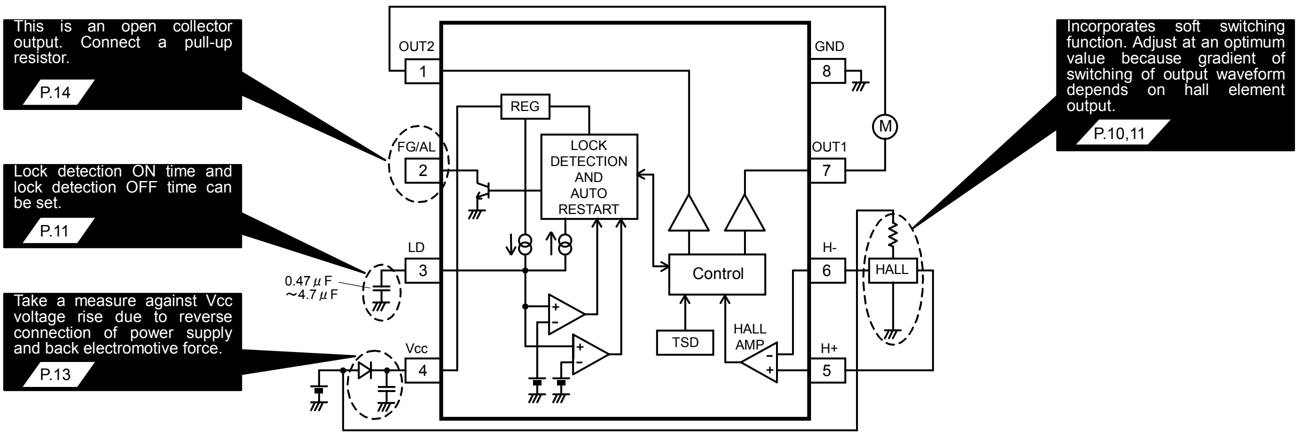
◎BA6427F、BA6428F



REG : Internal reference voltage TSD : Thermal shutdown(heat rejection circuit)

PIN No.	Terminal name	Function
1	OUT2	Motor output terminal 2
2	FG/AL	Rotating speed pulse signal/Lock alarm signal output terminal
3	LD	Lock detection and automatic restart capacitor connecting terminal
4	Vcc	Power supply terminal
5	H+	Hall input terminal +
6	H-	Hall input terminal -
7	OUT1	Motor output terminal 1
8	GND	GND terminal

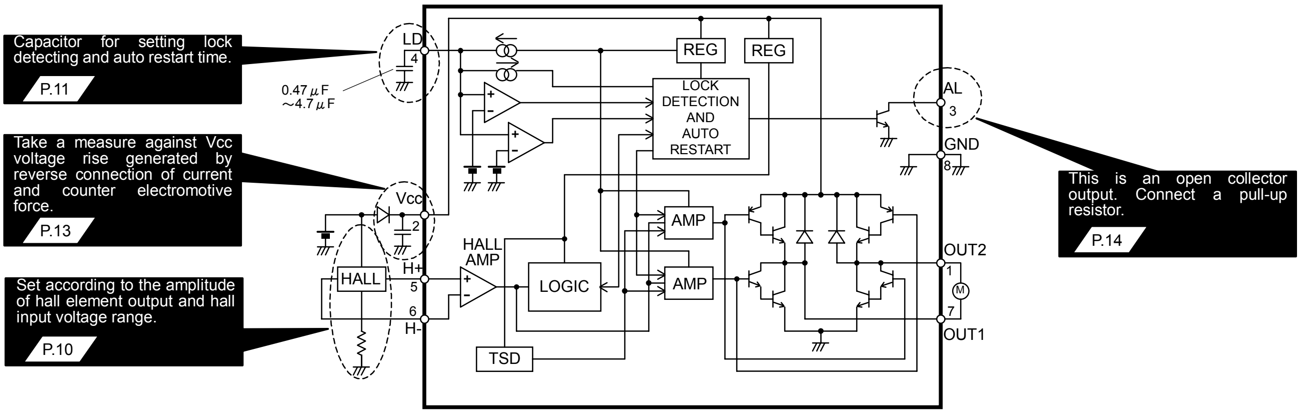
◎BA6908F、BA6906F



REG : Internal reference voltage TSD : Thermal shutdown(heat rejection circuit)

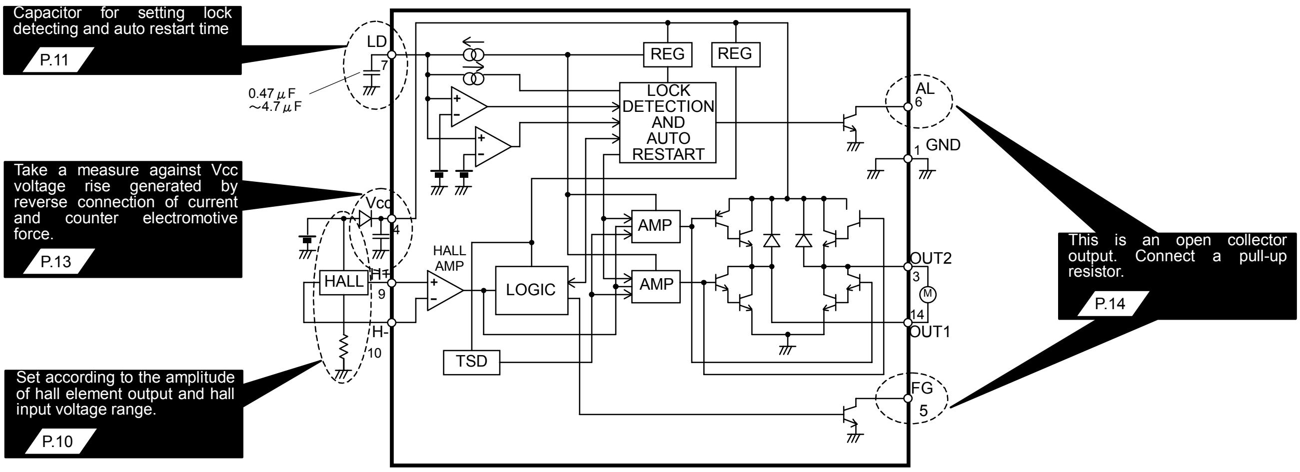
PIN No.	Terminal name	Function
1	OUT2	Motor output terminal 2
2	FG/AL	Rotating speed pulse signal/Lock alarm signal output terminal
3	LD	Lock detection and automatic restart capacitor connecting terminal
4	Vcc	Power supply terminal
5	H+	Hall input terminal +
6	H-	Hall input terminal -
7	OUT1	Motor output terminal 1
8	GND	GND terminal

◎BA6423AF



PIN No.	Terminal name	Function
1	OUT2	Motor output terminal2
2	Vcc	Power supply terminal
3	AL	Lock alarm signal output terminal
4	LD	Lock detecting and auto restart capacitor connecting terminal
5	H+	Hall input terminal+
6	H-	Hall input terminal-
7	OUT1	Motor output terminal1
8	GND	GND terminal

◎BA6424AFS



PIN No.	Terminal name	Function	PIN No.	Terminal name	Function
1	GND	GND terminal	9	H+	Hall input terminal+
2	N.C.		10	H-	Hall input terminal-
3	OUT2	Motor output terminal2	11	N.C.	
4	Vcc	Power supply terminal	12	N.C.	
5	FG	Rotating speed pulse signal output terminal	13	N.C.	
6	AL	Lock alarm signal output terminal	14	OUT1	Motor output terminal1
7	LD	Lock detection and auto restart capacitor connecting terminal	15	N.C.	
8	N.C.		16	N.C.	

●Description of operations

Function table

	BA6427F	BA6428F	BA6908F	BA6906F	BA6423AF	BA6424AFS	Reference page
Lock protection and automatic restart	○	○	○	○	○	○	P.10
Soft switching function			○	○			P.10
FG output	○		○			○	P.14
AL output		○		○	○	○	P.14

1) Lock protection and automatic restart

Lock detection ON time (TON) and lock detection OFF time (TOFF) is set by charging and discharging of external capacitor of LD terminal.

$$\text{TON(Lock detection ON time)} = \frac{C\cdot(\text{VLDCL-VLDCP})}{\text{ILDC}}$$

$$\text{TOFF(Lock detection OFF time)} \frac{C\cdot(\text{VLDCL-VLDCP})}{\text{ILDD}}$$

C : Capacity of capacitor equipped externally on LD terminal
VLDCL : LD terminal clamping voltage
VLDCP : LD terminal comparator voltage
ILDC : LD terminal charging current
ILDD : terminal discharging current

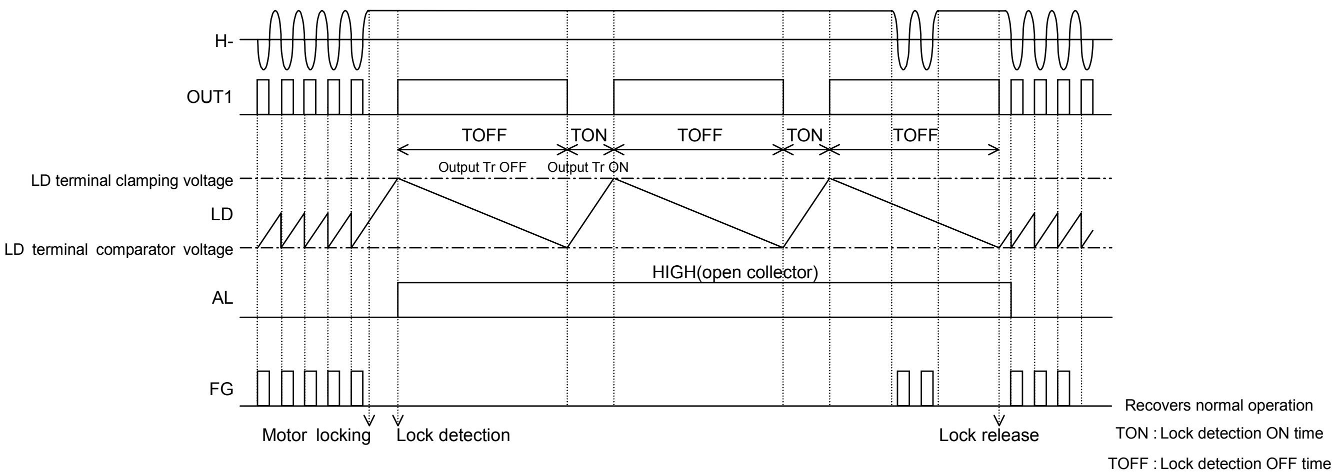


Fig.25 Lock protection (CR timer system) timing chart

2) Soft switching (silent drive setting) ＜BA6908F、BA6906F＞

Input signal to hall amplifier is amplified to produce an output signal.

When the hall element output signal is small, the gradient of switching of output waveform is gentle; When it is large on the contrary, the gradient of switching of output waveform is steep. Gain of 500 times (typical value) is provided between input and output, therefore enter an appropriate hall element output to IC where output waveform swings sufficiently.

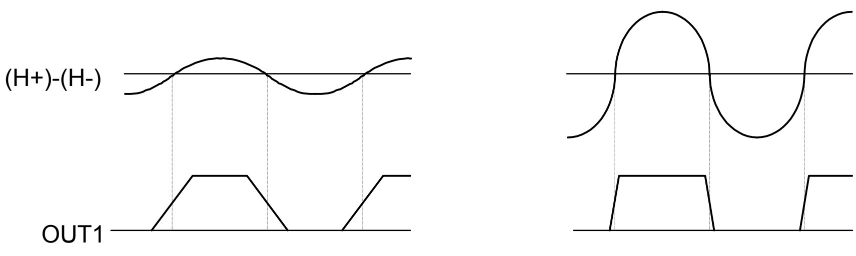


Fig.26 Relation between hall element output amplitude and output waveform

3) Hall input setting

Hall input voltage range is shown in operating conditions.

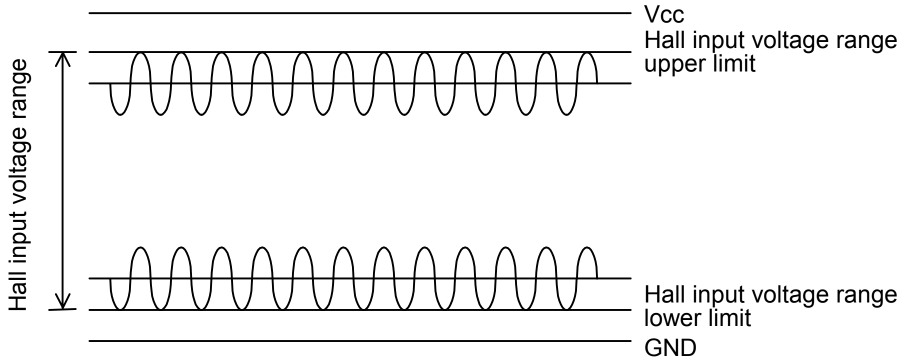
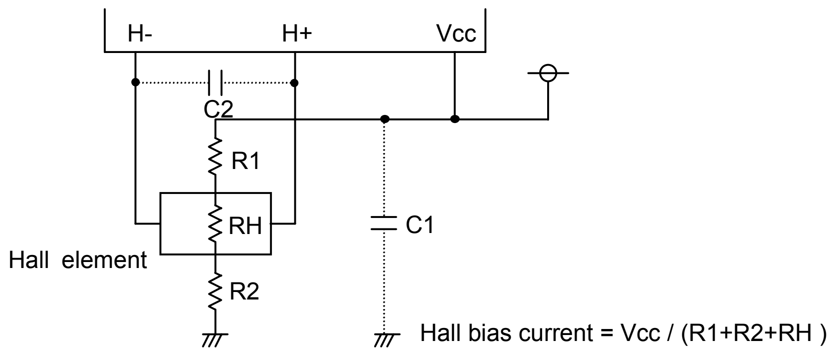


Fig.27 Hall input voltage range

Adjust the value of hall element bias resistor R1 and R2 in Fig 28 so that the input voltage of a hall amplifier is input in "hall input voltage range" including signal amplitude.

◯Reducing the noise of hall signal

Hall element may be affected by Vcc noise or the like depending on the wiring pattern of board. In this case, place a capacitor like C1 in Fig 28. In addition, when wiring from the hall element output to IC hall input is long, noise may be loaded on wiring. In this case, place a capacitor like C2 in Fig. 28.



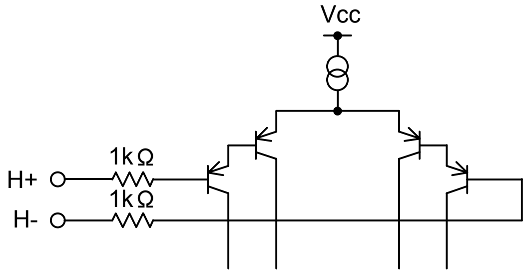
Setting R2=0 ohm is acceptable for BA6427F, BA6428F, BA6908F, and BA6906F.
Setting R1=0 ohm is acceptable for BA6423AF and BA6424AFS.

Fig.28 Application near hall signal

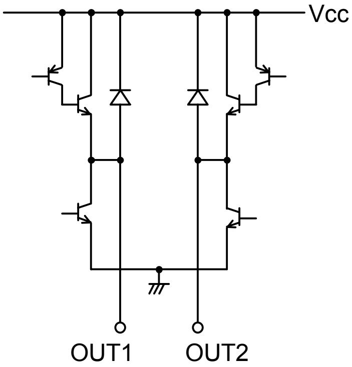
●Equivalent circuit

◎BA6427F、BA6428F、BA6908F、BA6906F

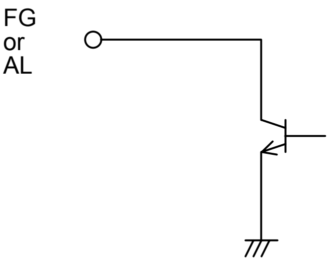
1) Hall input terminal



2) Motor output terminal

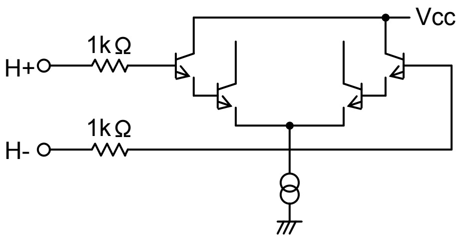


3) FG signal output terminal or
AL signal output terminal

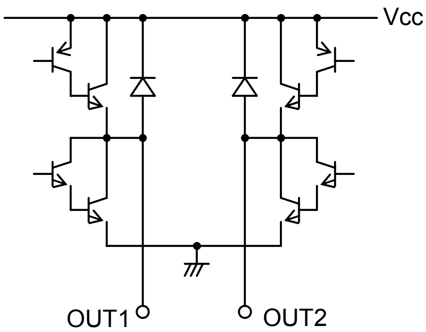


◎BA6423AF、BA6424AFS

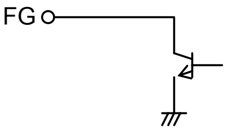
1) Hall input terminal



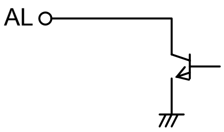
2) Motor output terminal



3) FG output terminal



4) AL output terminal



●Safety measure

1) Reverse connection protection diode

Reverse connection of power results in IC destruction as shown in Fig 29. When reverse connection is possible, reverse connection protection diode must be added between power supply and Vcc.

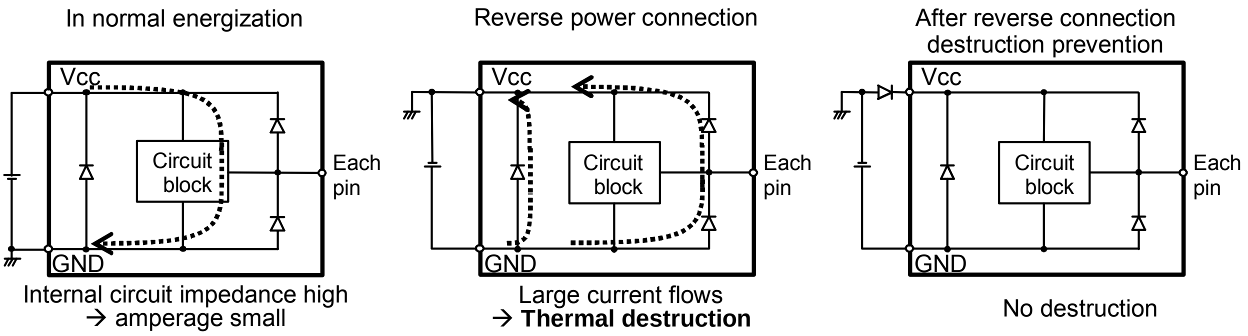


Fig.29 Flow of current when power is connected reversely

2) Measure against Vcc voltage rise by back electromotive force

Back electromotive force (Back EMF) generates regenerative current to power supply. However, when reverse connection protection diode is connected, Vcc voltage rises because the diode prevents current flow to power supply.

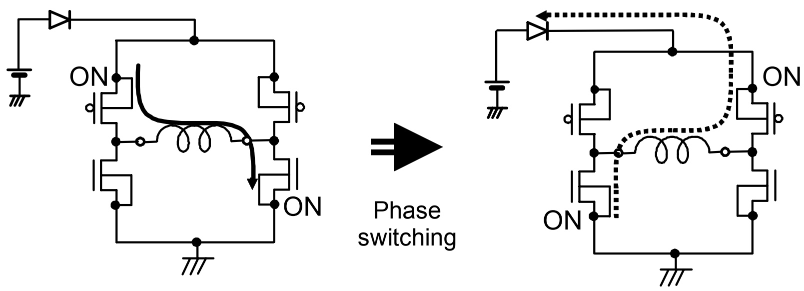


Fig.30 Vcc voltage rise by back electromotive force

When the absolute maximum rated voltage may be exceeded due to voltage rise by back electromotive force, place (A) Capacitor or (B) Zenner diode between Vcc and GND. It necessary, add both (C).

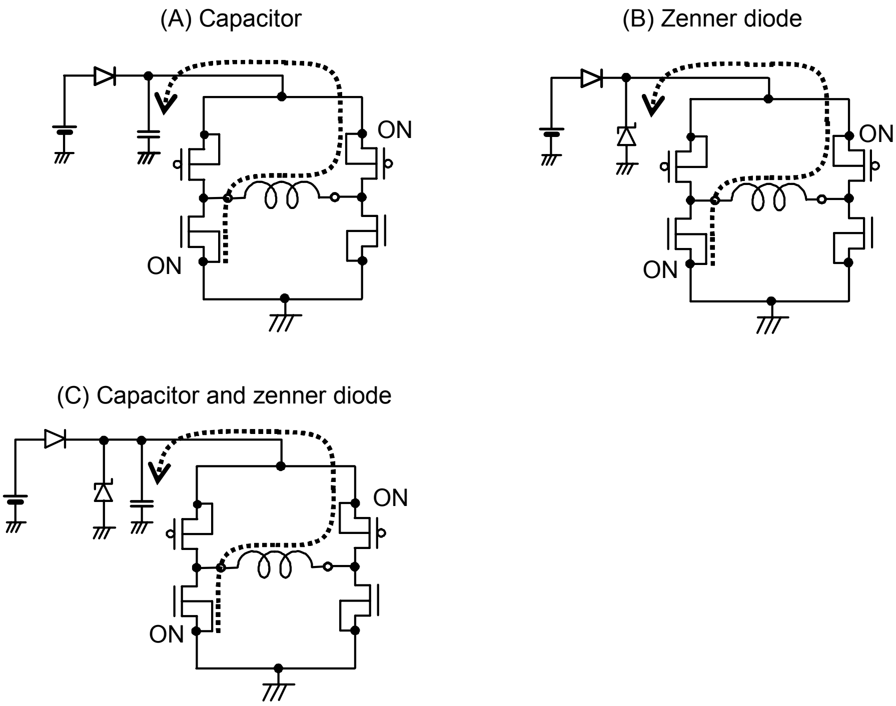


Fig31. Measure against Vcc voltage rise

3) Problem of GND line PWM switching

Do not perform PWM switching of GND line because GND terminal potential cannot be kept to a minimum.

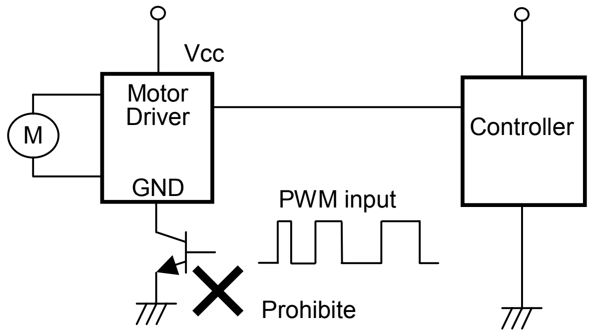


Fig.32 GND line PWM switching prohibited

4) FG and AL output

FG and AL output is an open collector and requires pull-up resistor.

The IC can be protected by adding resistor R1. An excess of absolute maximum rating, when FG or AL output terminal is directly connected to power supply, could damage the IC.

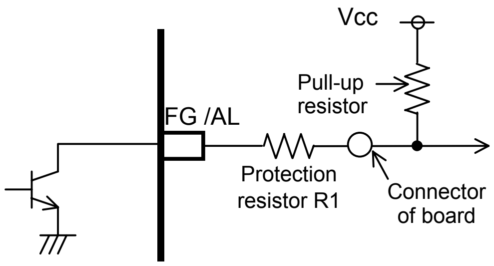


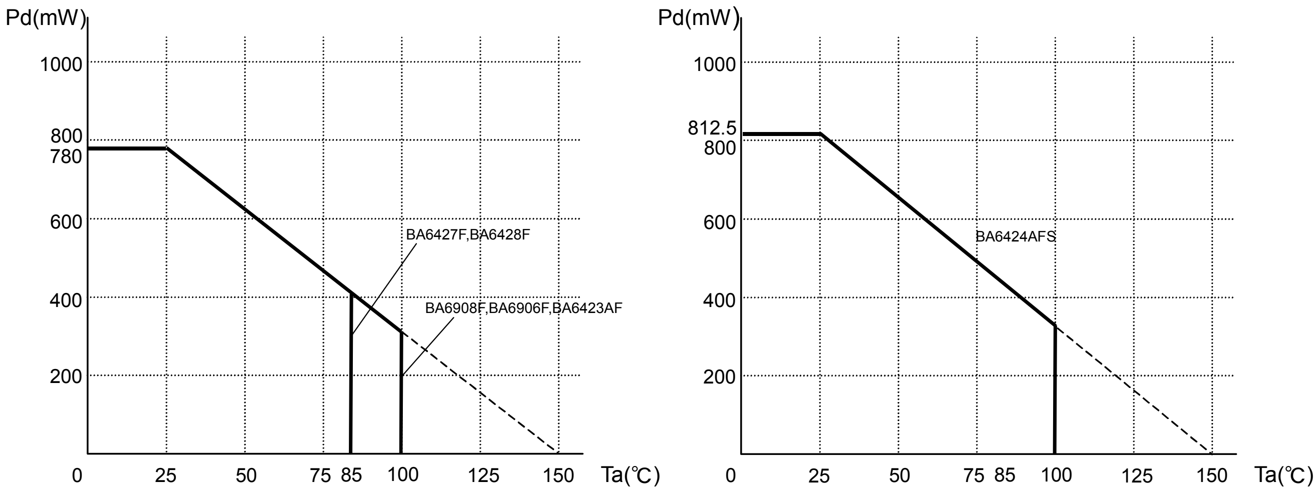
Fig.33 Protection of FG and AL terminal

●Thermal derating curve

Thermal derating curve indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient is determined by thermal resistance θja.

Thermal resistance θja depends on chip size, power consumption, package ambient temperature, packaging condition, wind velocity, etc., even when the same package is used. Thermal derating curve indicates a reference value measured at a specified condition. Fig.34 shows a thermal derating curve.

(Value when mounting FR4 glass epoxy board 70 [mm] x 70 [mm] x 1.6 [mm] (copper foil area below 3 [%]))



＊Reduce by 6.24mW/℃ over 25℃.＜BA6427F、BA6428F、BA6908F、BA6906F、BA6423AF＞

＊Reduce by 6.5mW/℃ over 25℃.＜BA6424AFS＞

(On 70.0mm×70.0mm×1.6mm glass epoxy board)

Fig.34 Thermal derating curve

●Cautions on use

1) Absolute maximum ratings
An excess in the absolute maximum rations, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2) Connecting the power supply connector backward
Connecting of the power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.

3) Power supply line
Back electromotive force causes regenerated current to power supply line, therefore take a measure such as placing a capacitor between power supply and GND for routing regenerated current. And fully ensure that the capacitor characteristics have no problem before determine a capacitor value. (when applying electrolytic capacitors, capacitance characteristic values are reduced at low temperatures)

4) GND potential
The potential of GND pin must be minimum potential in all operating conditions. Also ensure that all terminals except GND terminal do not fall below GND voltage including transient characteristics. However, it is possible that the motor output terminal may deflect below GND because of influence by back electromotive force of motor. Malfunction may possibly occur depending on use condition, environment, and property of individual motor. Please make fully confirmation that no problem is found on operation of IC.

5) Thermal design
Use a thermal design that allows for a sufficient margin in light of the power dissipation(Pd) in actual operating conditions.

6) Inter-pin shorts and mounting errors
Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.

7) Actions in strong electromagnetic field
Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.

8) ASO
When using the IC, set the output transistor so that it does not exceed absolute maximum rations or ASO.

9) Thermal shut down circuit
The IC incorporates a built-in thermal shutdown circuit (TSD circuit). Operation temperature is 175℃(typ.) and has a hysteresis width of 25℃(typ.). When IC chip temperature rises and TSD circuit works, the output terminal becomes an open state. TSD circuit is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operation this circuit or use the IC in an environment where the operation of this circuit is assumed.

10) Testing on application boards
When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.

11) GND wiring pattern
When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.

12) Capacitor between output and GND
When a large capacitor is connected between output and GND, if Vcc is shorted with 0V or GND for some cause, it is possible that the current charged in the capacitor may flow into the output resulting in destruction. Keep the capacitor between output and GND below 100uF.

13) IC terminal input
When Vcc voltage is not applied to IC, do not apply voltage to each input terminal. When voltage above Vcc or below GND is applied to the input terminal, parasitic element is actuated due to the structure of IC. Operation of parasitic element causes mutual interference between circuits, resulting in malfunction as well as destruction in the last. Do not use in a manner where parasitic element is actuated.

14) In use
We are sure that the example of application circuit is preferable, but please check the character further more in application to a part which requires high precision. In using the unit with external circuit constant changed, consider the variation of externally equipped parts and our IC including not only static character but also transient character and allow sufficient margin in determining.

●Ordering part number

・Please order by ordering part number. ・Please confirm the combination of each items. ・Please write the letter close to left when column is blank.

B	A	6	4	2	7	F	−	E	2

Part Number
- ・BA6427 ・BA6428
- ・BA6908 ・BA6906
- ・BA6423A ・BA6424A

Package Type
- ・F : SOP8
- ・FS : SSOP-A16

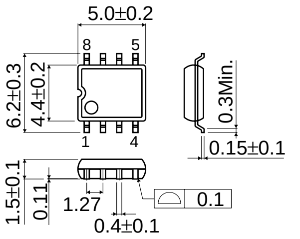
Package specification

E2 Emboss tape read Pin 1 opposite draw- out side

●PHYSICAL DIMENSION

SOP8

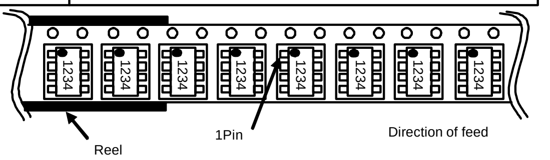
〈Dimension〉



(Unit:mm)

〈Tape and Reel information〉

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the lower right when you hold reel on the left hand and you pull out the tape on the right hand)



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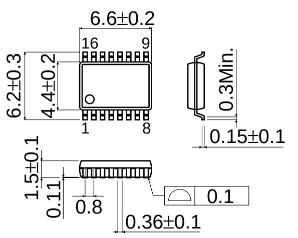
SSOP-A16

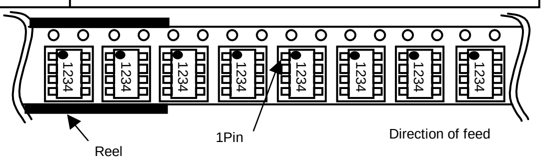
〈Dimension〉



(Unit:mm)

〈Tape and Reel information〉

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the lower right when you hold reel on the left hand and you pull out the tape on the right hand)



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